MM3412

Study program / course: Mechanical Engineering

Type and level of study: Master academic studies

Course: **METAL HEAT TREATMENT**

Lecturers:: **Adamović D. Dragan, Lazić N. Vukić**

Status of course: Elective for module M_1, III semester

Number of ECTS: 6

Precondition: general knowledge from Physics, Chemistry and Materials science

The objective of course

The main course objective is getting acquainted with the types of heat and chemical heat treatment, as well as with methods of their realisation. Students will be introduced with structural and physical – chemical changes, as well as with flaws that are made during the process. Also, they will acquire certain knowledge in relation to selection of parameters of heat and chemical heat treatment for different metals and alloys, as well as of testing the quality of listed treatments.

The outcome of course

Upon successful completition of obligations, students should understand the significance of heat and chemical heat treatment, as well as of changes (structural and physical) that are realised during the process. Based on acquired knowledge, students are qualified to be able to properly select and apply heat and chemical heat treatment for different metals and alloys, as well as to determine their the most important characteristics.

Syllabus

Theoretical study

Significance of the heat treatment, basic terms for heat treatment, binary phase diagrams, metastabile Fe-Fe_3C diagram, changes in structure during cooling, phase changes for steel solid state, transformation diagrams (isothermal decomposition diagrams – TTT diagram, subcooling diagrams, continuous cooling diagrams – CCT diagrams), heat treatment procedures – annealing, quenching, hardening, tempering, thermo-mechanical processing, reaustenisation, surface hardening, chemical heat treatment – carburizing, nitriding, carbonitriding, cyanidation, alitation etc., residual self stress and flaws that are realised during heat treatment, parameters selection for heat treatment – heating temperature, heating time, means of heating and cooling and equipment for heat treatment, heat treatment of ferrous metals (steels and cast iron), heat treatment of non-ferrous metals, heat treatment of welded joints, definition of demands for heat treatment in scope of technical documentation for manufacturing of machine parts, ways of development and new heat treatment processes.

Practical Studies*:Laboratory Exercises,*

Metallographic testing, Determination of critical temperatures Ac1 and Ac3, determination of austenite grain size, obtaining of isothermal decomposition diagrams (TTT diagram) and continuous cooling diagrams (CCT diagrams), determination of parameters and realisation of annealing, testing of hardenability, determination of parameters and realisation of hardening, determination of parameters and realisation of steel surface hardening, quality testing of chemical heat treatment (carburizing, nitriding), systematization of flaws and ways of their removal during heat treatment, testing of heat treatment influences to dynamical strength, procedures of equipment selection and design of heat treatment plants, heat treatment of aluminuim alloys, determination of parameters and realisation of heat treatment of welded joints, management procedures of processes and quality management for the heat treatment. Information technologies for heat treatment. In scope of study research project, students will be qualified for basic research activities in subject area.

Recommended reading

1. Јовановић, M., et al.: Machine materials, Faculty of Mechanical Engineering Kragujevac, 2003. (In Serbian)
2. Schumann, H.: Metallographie, translation into Serbian: Видојевић, H. et al., Agency for textbooks publishing SRS, Belgrade 1965.
3. Видојевић, H.: Metal heat treatment, Faculty of Technology and Metallurgy, Belgrade, 1973 (In Serbian)
4. Printed materials and electronic materials (In Serbian)

The number of hours of active teaching				Other classes 1
Theory: 3	Practical classes: 1.4	Other forms of teaching: 0.6	Research study: 0	

Methods of teaching

Lecturing is done through theoretical lectures and laboratory exercises.

Evaluation of knowledge (the maximum number of points 100)

Pre-final exam obligations	**points**	**Final exam**	**points**
Activities during the classes	10	Written exam or oral exam	30
Practical Studies	10		
Tests	30		
Seminars	20		